COMMERCIAL TEST REPORT

Report No. FMPE/TC/Comm./2020/1194 **March, 2020**
Report Valid Upto: March, 2027

HARNAM ROTAVATOR (7 FEET, B-54)

FARM MACHINERY TESTING CENTRE
DEPARTMENT OF FARM MACHINERY AND POWER ENGINEERING
COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA (PUNJAB) - 141 004

Approved By
GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE & FARMERS WELFARE
(DEPARTMENT OF AGRICULTURE, CO-OPERATION & FARMERS WELFARE)

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Manufacturer : **M/s Harnam Singh & Sons**
V.P.O. Kup Kalan, Malerkotla
Distt. Sangrur 148019
Punjab

HARNAM ROTAVATOR (7 FEET, B-54) (Gear Drive) (Tractor Operated)

Report No. FMPE/TC/Comm./2020/1194 Month: March Year: 2020

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(The College of Agricultural Engineering and Technology, PAU, Ludhiana is an approved Testing Centre by Department of Agriculture, Cooperation & Farmers Welfare (M&T Division), Ministry of Agriculture & Farmers Welfare, Govt. of India vide letter no. 8-1/2004-My. (I&P) dated September 14, 2010 and subsequent letters)

Type of test	:	COMMERCIAL
Name of machine	:	ROTAVATOR (7 FEET, B-54)
Test code referred	:	IS: 4931-1995 (Reaffirmed in Oct., 2004) (Agricultural Tractors-Rear mounted power take off); IS: 4468 (Pt-I)-1997 (Reaffirmed in Dec., 2012) (Agricultural wheeled Tractors Rear Mounted Three Point Linkage) & IS: 6690-1981 (Reaffirmed in Jan., 2002) (Blades for Rotavator for Power Tiller)
Test requested by	:	Harnam Singh & Sons. V.P.O. Kup Kalan, Malerkotla Distt. Sangrur 148019, Punjab
Testing authority	:	Farm Machinery Testing Centre Department of Farm Machinery and Power Engineering College of Agricultural Engineering and Technology Punjab Agricultural University Ludhiana-141004 (Punjab)
Period of test	:	2019
Report valid upto	:	March, 2027

1. This test report should not be reproduced in part or full without prior permission of the Head, Department of Farm Machinery and Power Engineering, Punjab Agricultural University, Ludhiana (Punjab).
2. The data given in the test report pertain to the particular machine submitted by manufacturer for commercial testing.
3. The data collected during the test do not in any way attribute to the durability of the machine.
4. The results reported in this report are observed values and no corrections have been applied for atmospheric and site conditions.

SELECTED CONVERSIONS

Sr. No.	Units	Conversion Factor
1.	**Force**	
	1kgf	9.80665 N
		2.20462 lbf
2.	**Power**	
	1hp	1.01387 metric hp (ps)
		745.7 W
	1ps	735.5 W
	1kW	1.35962 ps
3.	**Pressure**	
	1psi	6.895 kPa
	1kgf/cm^2	98.067 kPa = 735.56 mm of Hg
	1bar	100 kPa = 10 N/cm^2
	1mm of Hg	1.3332 m-bar

CONTENTS

1. SCOPE OF TEST

The scope of test was to check and assess the following:

1.1 LABORATORY TEST:

- Measurement of specifications
- Hardness of soil engaging parts
- Wear analysis of critical components

1.2 FIELD TEST:

- Rate of work
- Quality of work
- Ease of operations, maintenance and adjustments
- Labour requirement
- Defects, Breakdowns and Repairs

2. METHOD OF SELECTION

The rotavator was randomly selected by the Farm Machinery Testing Centre, PAU, Ludhiana for testing.

3. TEST PROCEDURE/ CODES

The implement was checked in accordance with IS:4931-1995 (Reaffirmed in Oct., 2004) (Agricultural Tractors-Rear mounted power take off); IS: 4468 (Pt-I)-1997 (Reaffirmed in Dec., 2012) (Agricultural wheeled Tractors Rear Mounted Three Point Linkage) & IS:6690-1981(Reaffirmed in Jan., 2002) (Blades for Rotavator for Power Tiller)

4. SPECIFICATIONS

4.1 General:

Name of Manufacturer & Address	:	Harnam Singh & Sons. V.P.O. Kup Kalan, Malerkotla Distt. Sangrur 148019, Punjab
Name of Machine	:	Rotavator (7 Feet, B-54)
Type	:	Tractor operated
Make	:	Harnam
Model	:	Harnam 7 Feet, B-54
Serial No.	:	597
Year of manufacture	:	2019
Working width (mm)	:	1870
Power source as recommended (hp)	:	50

Power source as used : Tractor, John Deere - 5310
Chassis No/Engine No. : PY5310SO13263 / PY3029D144765
Max. PTO Power, (hp) : 52.5

4.2 Constructional details (Refer Fig.1)

1	Mainframe	4	Primary gear box
2	Rotor axle	5	Hitch pyramid
3	Rotor blade	6	Disc

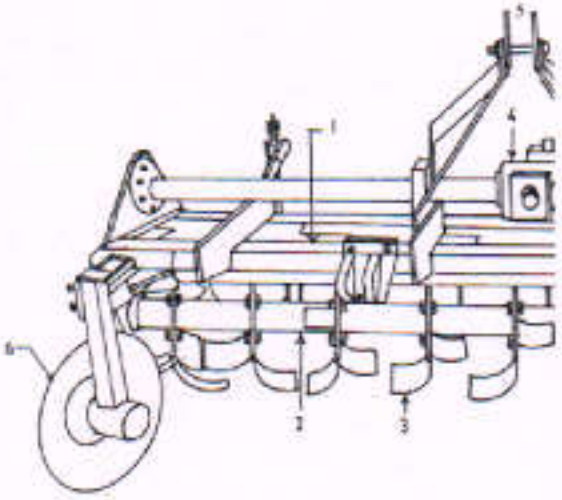

Fig.1: Schematic view of rotavator

4.2.1 Chassis/Main frame:

Constructional details: Main frame is fabricated using M.S. box section. One M.S. hollow box section of size 60×60×2025 mm is welded to it at front side. Two M.S. flats (L-shape) of size 610 mm (length) & 8.5 mm (thickness) are welded on both sides of the rotavator for the attachment of side plates to chassis. Two pieces of M.S. flats for attachment of trailing board to chassis of size760 mm (length) & 8 mm (thickness) are welded across its length. The hitch pyramid is bolted to the two supports of size 655 mm (length) & 10.5 mm (thickness) fitted on chassis.

4.2.2 Side plates:

Number : Two
Material : M.S. sheet
Dimensions (mm):
Secondary gear box side : 750×475×10.2
Opposite side : 675×475×8

Method of fixing: Side plates are fixed with five nuts & bolts on LHS and four nuts & bolts on RHS of the main frame. Depth adjusting skids are provided on both side below side plates. A secondary gearbox is fitted on the RHS side plate, as seen from front.

4.2.3 Trailing board:

Number : One
Material : M.S. sheet
Size (mm) : 2195×500

Method of fixing: The trailing board is hinged with the help of M.S rod having threads on its extreme ends passing through the two hinges welded to the main frame. The M.S. rod is attached to the M.S. bushes with the help of nuts & bolts.

Angle of trailing board in different position (degree)

	Hole Setting on rotavator			
Hole Setting on trailing board	**1**	**2**	**3**	**4**
A	78°	49°	26°	25°

Provision for locking: Two spring (180×30.3×4.6 mm and 88.5×30.3×4.6 mm) loaded M.S. rods of size 420 mm×15.8 mm ϕ are fitted on the trailing board. These are used to lift, lower and lock the trailing board by nut & bolt of size 75.6 mm×11.5 mm ϕ.

4.2.4 Rotor:

4.2.4.1 Axle:

Material : M.S. pipe

Constructional details: The rotor axle is fabricated from M.S. pipe of outer diameter 88.6 ϕ (mm) by welding nine M.S. flanges on it at a spacing of 220 mm.

Number and type of flanges : Ten, Circular
Size of flanges (mm) : 230 ϕ
Number and size of holes on each flange for fixing blades (mm) : 12, 15 ϕ
Number and size of holes on outer flanges for fixing the axle (mm) : 6 (on secondary gear box side) & 6 (on other side, 17 ϕ

Method of fixing: The rotor axle is fitted to the main frame through the mounting flanges tightened with nut and bolts to side plates (LHS and RHS) and is supported with bearings.

4.2.4.2 Rotor blade:

Number	:	Fifty four
Type	:	L-shape
Material	:	Carbon Steel
Thickness (mm)		
-Overall	:	7.3
-Beveled edge	:	2.0
Length of beveled edge (mm)	:	220
Width of beveled edge (mm)	:	20.8
Number, size and spacing of the hole on each blade for fixing it to the flanges (mm)	:	Two, 15ϕ, 45.3
Dimensions of hatchet blade (mm)	:	Refer Fig. 2

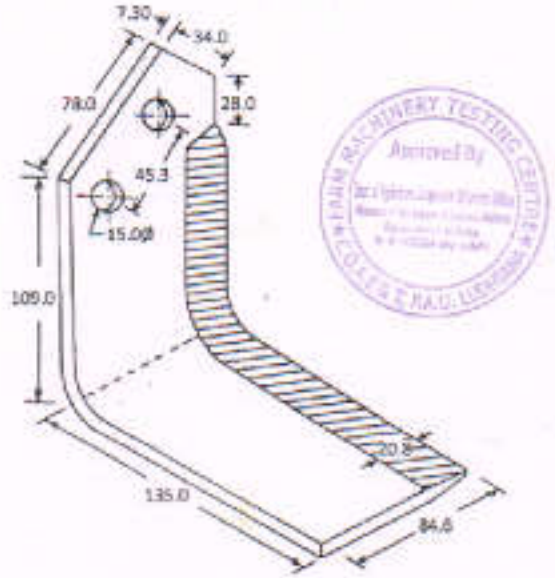

Fig.2: Dimensions of hatchet blade (mm)

Arrangement of blades on the axle: There are six blades on each flange with tree left - three right alternate combination.
Method of mounting: Blades are fixed with nuts & bolts.

4.2.5 Primary reduction:

Type : Spur and bevel gear

Method of power transmission: It takes drive from the tractor PTO shaft through a propeller shaft and transmits it to the secondary gearbox of the rotavator at right angle through bevel and pinion.

No. of teeth on driver gear	:	16
No. of teeth on driven gear	:	17
No. of teeth on bevel gear	:	22
No. of teeth on bevel pinion	:	11
Reduction ratio	:	1 : 0.47
Lubricating oil capacity, (l)		
As specified	:	3.5 (SAE140/EP140 Grade)
As observed	:	3.5
Oil change period, (specified) h	:	200

Dimensions of splined end of pinion shaft (Refer Fig.3):

Specification	As per IS: 4931-1995 (Reaffirmed in Oct., 2004)	As observed	Remarks
1	2	3	4
DΦ	34.79±0.06	34.75	Conforms
dΦ	28.91±0.05	28.4	Does not conform
S	8.69	9.0	Does not conform
R	6.7±0.25	Not provided	Does not conform
x	Angle, 30^0	27°	Does not conform
G	7.0	6.3	Does not conform
H	38.0	32.2	Does not conform
A	54.0 (min.)	65.2	Conforms
B	76.0 (min.)	65.2	Does not conform

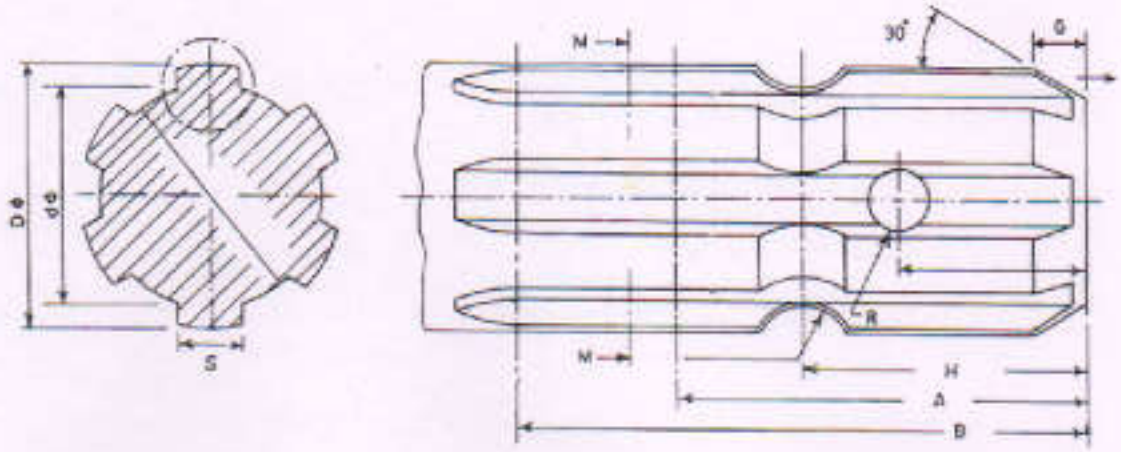

Fig.3: Dimensions of implement power input shaft

No. of teeth on driver gear	:	16
No. of teeth on driven gear	:	17
No. of teeth on bevel gear	:	22
No. of teeth on bevel pinion	:	11
Reduction ratio	:	1 : 0.47
Lubricating oil capacity, (l)		
As specified	:	3.5 (SAE140/EP140 Grade)
As observed	:	3.5
Oil change period, (specified) h	:	200

Dimensions of splined end of pinion shaft (Refer Fig.3):

Specification	As per IS: 4931-1995 (Reaffirmed in Oct., 2004)	As observed	Remarks
1	2	3	4
DΦ	34.79±0.06	34.75	Conforms
dΦ	28.91±0.05	28.4	Does not conform
S	8.69	9.0	Does not conform
R	6.7±0.25	Not provided	Does not conform
x	Angle, 30^0	27^0	Does not conform
G	7.0	6.3	Does not conform
H	38.0	32.2	Does not conform
A	54.0 (min.)	65.2	Conforms
B	76.0 (min.)	65.2	Does not conform

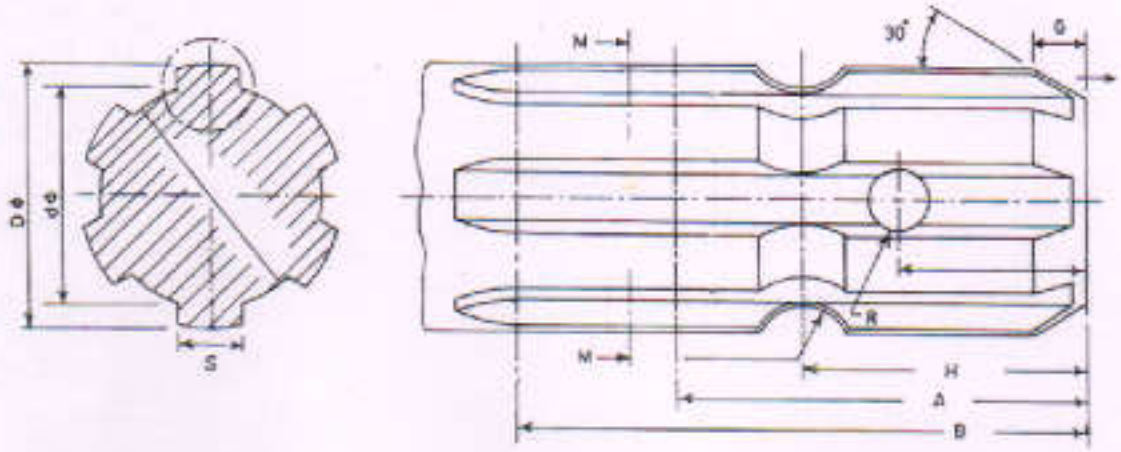

Fig.3: Dimensions of implement power input shaft

4.2.6 Secondary reduction:

Type : Gear drive

Method of power transmission: It takes drive from the primary gear box and transmits it to the rotor axle of the rotavator.

Location	:	On RHS plate, as seen from front
Lubricating oil capacity, (l)		
-As per specified	:	4 (SAE140/CL140/EP140 Grade)
Oil change period, (specified) h	:	200
No. of gears	:	Three
Type of gears	:	Spur gears
No. of teeth on drive gear	:	21
No. of teeth on idle gear	:	36
No. of teeth on driven gear	:	28
Reduction ratio	:	1 : 0.71
Diameter of rotor with blades, mm	:	428.6
Speed of the rotor corresponding to Standard 540 rpm speed of PTO, rpm	:	190.6
Peripheral speed of the rotor blades corresponding to Standard PTO Speed 540 rpm, m/sec	:	4.28

4.2.7 Propeller shaft:

Type: Telescopic (with two segments) having one universal joint on each segment with splined ends to insert the PTO of tractor and drive shaft of gear box.

Length of shaft, mm		
-Minimum	:	840
-Maximum	:	960
Mass of shaft, kg	:	18.44

Locking provision: Spring loaded locking pin is provided.

Safety provision: Not provided on the implement propeller shaft for safety against overloading of rotor axle.

Propeller shaft insert dimension (Refer Fig.4):

Sr. No.	Notations	Dimensions (mm)		Conformity to IS
		As per IS: 4931-1995 (Reaffirmed in Oct., 2004)	As observed	
1.	Dϕ	34.93 ± 0.03	30.2	Does not conform
2.	dϕ	29.7 ± 0.1	35	Does not conform
3.	W	8.69	7.3	Does not conform
4.	B	54 (min.)	60.5	Conforms

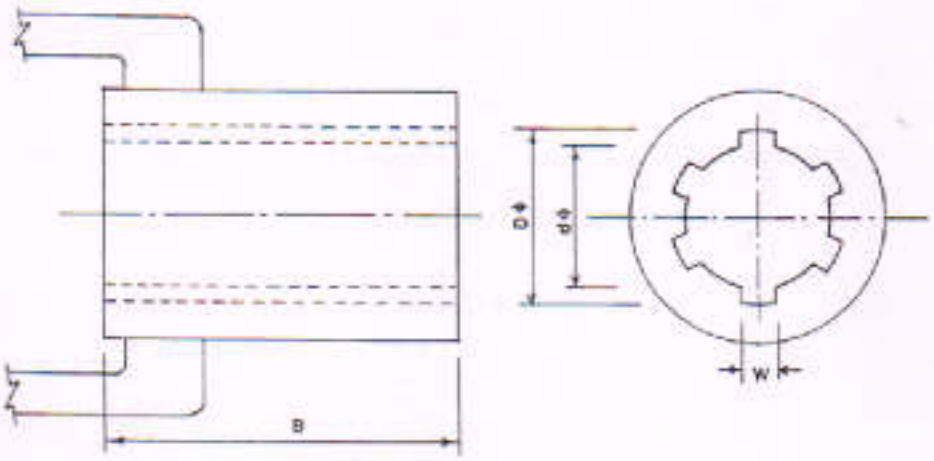

Fig. 4: Propeller shaft insert dimensions

4.2.8 Depth control mechanism:

Type	:	Curved, M.S. Flat
Number	:	Two (one each side)
Material	:	M.S. flat

Constructional details: Depth control skids are fabricated from two M.S. flats of size (590×48.8×8.1 mm) in curved shape and bolted their one end directly to the side plates and other end to the side plates through a depth adjustment rack.

4.2.8.1 Depth adjusting rack

Number	:	One on each side
Material and size, mm	:	M.S. flat,179.9×52.5×10.2
No. and size of step on each rack, mm	:	Three, 22.0
Centre to centre distance between the holes, mm	:	22.0
No. of adjustments	:	4
Range of depth adjustment, mm	:	upto 69

4.2.9. Hitch pyramid:

Type	:	Clevis type mounting
Material	:	M.S plate

Constructional details: The lower hitch brackets are fabricated from 163.5×138.2×16.4 mm thick C.I and bolted to the front M.S. square pipe of main frame.

Specification of Hitch Pyramid as per IS 4468-1997(Pt-I)(Reaffirmed in 2012):

Sr. No.	Specifications	Dimension (mm)		Remarks
		As per IS	As Measured	
1	2	3	4	5
1.	Upper hitch points (Category I/ Category II):			
	Diameter of hitch pin hole	19.3-19.5/ 25.7-25.9	26	Does not conform
	Width between inner faces of yoke	44.5 (min.)/ 52 (min.)	60.6	Conforms
	Width between outer faces of yoke	69 (max.)/ 86 (max.)	82	Conforms
2.	Lower hitch points (Category I/ Category II):			
	Diameter of hitch pin hole	22.4-22.65/ 28.7-29.0	28.5	Does not conform
	Width between inner face of yoke	44.5 (min.)/ 52 (min.)	54.6	Conforms
	Width between outer face of yoke	69 (max.)/ 86 (max.)	86	Conforms
	Diameter of hitch pin	21.8-22.0/ 27.8-28.0	27.8	Conforms
	Linch pin hole distance	39/49 (min.)	94	Conforms
	Diameter for linch pin	12.0 (min.)	7.8	Does not conform
3.	Mast height	460±1.5/ 610±1.5	531 (adjustable)	Does not conform
4.	Lower hitch point span	683±1.5/ 825±1.5	777	Does not conform

*Hitch pyramid partially confirms to category II

4.3 Overall dimensions (mm)

Length	Width	Height
2250	1230	1040

4.4 Operational mass (kg) : 490 (without shaft)

4.5 Colour : Orange

5. LABORATORY TEST

5.1 Hardness: The surface hardness of blade was recorded as under:

Sr. No.	Hardness				Remarks	
	As per IS:6690-1981		As observed (HB)		Shank portion	Edge portion
	Shank portion	Edge portion	Shank portion	Edge portion		
1.	(37–45 HRC)	(56±3 HRC)	48.3	42.7	Partially conforms	Does not conform
2.			50.7	42.7		
3.			49.3	46.3		
4.			43.7	43.7		
5.			47.0	42.7		
6.			42.0	40.0		
7.			45.0	42.3		
8.			47.7	46.0		
9.			46.0	46.7		

6. FIELD PERFORMANCE TEST

The rotavator was operated for a total of 126.75 hours out of which for wet land test (0.75 hour), dry land test (1.00 hours) in medium soil for performance test and 125 hours for long run test. The results of performance tests are given in ANNEXURE-I & II and are summarized in Table 1 & 2 respectively.

6.1 Wet land operation:

The rotavator was operated in heavy soil for puddling operation.

Table: 1 SUMMARY OF FIELD PERFORMANCE TEST (Wet land operation)

Sr. No.	Parameter	Range
	Type of soil	Heavy
1.	Engine speed (rpm)	
	No load	2400
	On load	2300
2.	Average speed of operation (km/h)	2.15
3.	Average wheel slip (%)	14.65
4.	Average water over puddle (cm)	7.81
5.	Average puddle depth (cm)	11.40
6.	Average wheel sinkage (cm)	19.00
7.	Average Puddling index (%)	86.67
8.	Field efficiency* (%)	80.00

9.	Fuel consumption		
		l/h	6.90-9.72
		l/ha	22.50-32.65
10.	Field capacity (ha/h)		0.32

*Assumed

6.1.1 Quality of work

- The depth of puddle was recorded as 11.40 cm
- The pudding index was recorded as 84-90 % in single operation.

6.2 Dry land operation:

Table: 2 SUMMARY OF FIELD PERFORMANCE TEST (Dry land operation)

Sr. No.	Parameters		Range
1.	Type of soil		Heavy
2.	Soil bulk density after operation (g/cc) on dry basis		1.43-1.91
3.	Average soil moisture (%) on dry basis		13.08
4.	Engine speed (rpm)		
		No load	2400
		On load	2375
5.	Average forward speed of operation (km/h)		2.70
6.	Average wheel slip (%)		3.28
7.	Average depth of cut (cm)		6.50
8.	Working width (m)		1.86
9.	Area covered (ha/h)		0.40
10.	Time required to cover one hectare (h)		2.50
11.	Mean mass diameter (mm)		5.02
12.	Field efficiency* (%)		80.00
13.	Fuel consumption		
		l/h	5.48-7.20
		l/ha	13.29-18.14

*Assumed

6.2.1 Rate of work

- The average rate of work in heavy soil was recorded as 0.40 ha/h at the forward speed of 2.70 km/h.
- The time required to cover one hectare area was recorded as 2.50 h.

6.2.2 Quality of work:

- The depth of operation was recorded as 6.3-6.6 cm.
- The average mean mass diameter was 5.02 mm.

6.3 Wear analysis:

6.3.1 On mass basis

Sr. No.	Initial Mass (g)	Final Mass (g)	Percentage of wear on mass basis	
			After 126.75 h	Per hour
1.	1096.83	1055.55	3.76	0.030
2.	1117.24	1078.05	3.51	0.028
3.	1109.30	1067.65	3.75	0.030
4.	1081.88	1042.06	3.68	0.029
5.	1094.37	1053.32	3.75	0.030
6.	1088.08	1055.41	3.00	0.024
7.	1097.87	1059.50	3.49	0.028
8.	1094.20	1054.57	3.62	0.029
9.	1089.98	1052.55	3.43	0.027
Remarks: The hourly percentage wear of blade on mass basis was recorded as 0.024 to 0.030 % .				

6.4 Labour requirement:

One skilled operator is needed to operate the tractor and the rotavator simultaneously.

6.5 Adequacy of power of recommended prime mover:

The power of the prime mover recommended by the applicant was 50 hp.

6.6 Service and maintenance:

- Requires checking & tightening of all nuts & bolts of the implement specially blade, lower hitch clamps and propeller shaft bolts. The trash and soil wrapped on the rotor axle needs to be removed after the day's operation.

6.7 Ease of operation & adjustments:

- The operator can easily adjust and control the implement from operator's seat in the field as the adjustments are within the reach of operator. However, the operator has to get down from the tractor in order to raise/lower the depth adjusting skids.

7. DEFECTS, BREAKDOWNS AND REPAIRS

There were no defect, breakdown and repair during testing.

8. SUMMARY OF OBSERVATIONS, COMMENTS AND RECOMMENDATIONS

8.1 The rate of work was recorded as 0.32 & 0.40 ha/h at forward speed of 2.15 & 2.70 km/h in wet land and dry land operations, respectively.

8.2 The depth of puddle was recorded as 11.4 cm and depth of operation was recorded as 6.3-6.6 cm for dry land.

8.3 Dimension of splined end of pinion shaft conforms partially to the IS: 4931- 1995 (Reaffirmed in 2004).

8.4 The dimensions of propeller shaft insert conforms partially to the IS: 4931- 1995 (Reaffirmed in 2004).

8.5 The specification of implement hitch conforms partially to the IS: 4468 (Pt-I)- 1997 (Reaffirmed in 2012). It is recommended that the same should be provided conforming to the relevant Indian Standards.

8.6 The hardness of rotavator blades at shank & edge was recorded as 42.0 to 50.7 and 40.0 to 46.3 HRC, against the requirement of 37 to 45 HRC and 56±3 HRC respectively. The hardness at shank portion of blades partially confirms to the prescribed range and hardness at edge portion of blades are on lower side than the required relevant Indian Standard.

8.7 The hourly rate of wear of blades on mass basis varied from 0.024 to 0.030%.

8.8 Adequacy of literature

Operator manual, parts catalogue, specification manual and service manual in english were provided. However, this may be brought out in vernacular language also for the guidance of user and technical personnel.

9. APPLICANT'S COMMENTS

The applicant agreed with the findings of test report.

TESTING AUTHORITY

Name	Signature
INCHARGE Farm Machinery Testing Centre	4/7/2020
HEAD Department of Farm Machinery and Power Engineering	4/7/2020

Test conducted and test report prepared by: **Rajesh Goyal** Assistant Engineer, **Manpreet Singh** Asstt. Agri. Engineer, **Varinder Singh Saimbhi** Asstt. Agri. Engineer and **Rajinder Singh** Demonstrator (Agri. Engg.)

Report Valid Upto: March, 2027

FARM MACHINERY TESTING CENTRE, DEPARTMENT OF FARM MACHINERY AND POWER ENGINEERING, COLLEGE OF AGRI. ENGG. & TECHNOLOGY, PAU, LUDHIANA

ANNEXURE I

FIELD PERFORMANCE RESULTS (WET LAND)

Place of test: Near Remote Sensing Centre, PAU, Ludhiana

Sr. No.	Parameters	Test Trials		
		I	II	III
1.	Date of test	29.06.2019	29.06.2019	29.06.2019
2.	Duration of test (min)	15	15	15
3.	Gear used	1st low		
4.	*Type of soil*	Heavy		
5.	Engine speed			
	-No load	2400	2400	2400
	-On load	2300	2300	2300
6.	Forward speed (km/h)	2.29	2.09	2.06
7.	Wheel slip (%)	13.60	15.28	15.08
8.	Water over puddle (cm)	7.8	7.2	8.4
9.	Depth of puddle (cm)	11.4	11.4	11.4
10.	Wheel sinkage (cm)	18	20	19
11.	Area covered (ha/h)	0.34	0.31	0.31
12.	Pudding index (%)	84.00	90.00	86.00
13.	Fuel consumption (l/h)	9.72	9.55	6.90
14.	Fuel consumption (l/ha)	28.54	32.65	22.50

ANNEXURE II

FIELD PERFORMANCE RESULTS (DRY LAND)

Place of test: Near Remote Sensing Centre, PAU, Ludhiana

Sr. No.	Parameters	Test Trials		
		I	II	III
1.	Date of test	18.06.2019	18.06.2019	18.06.2019
2.	Duration of test (min)	20	20	20
3.	Gear used	1st low		
4.	Furrow length (m)	45.5	46.3	44.6
5.	Type of soil	Heavy		
6.	Bulk density (g/cc)	1.78	1.91	1.43
7.	Soil moisture on dry basis	12.52	12.41	14.29
8.	Engine speed			
	-No load	2400	2400	2400
	-On load	2375	2370	2372
9.	Forward speed (km/h)	2.77	2.67	2.67
10.	Wheel slip (%)	3.21	2.18	4.46
11.	Depth (cm)	6.6	6.3	
12.	Width (m)	1.86	1.86	1.865
13.	Area covered (ha/h)	0.41	0.40	0.40
14.	Time required for one ha (h)	2.4	2.5	2.5
15.	Mean mass diameter (mm)	5.99	6.20	2.85
16.	Field efficiency (%)*	80	80	80
17.	Fuel consumption (l/h)	5.48	7.20	6.94
18.	Fuel consumption (l/ha)	13.29	18.14	17.43

*Assumed